Daily UVB exposure levels in high-school students measured with digital dosimeters

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UV radiation exposure increases skin cancer risk. A substantial portion of a person's UV exposure occurs before the age of 18 years. We sought to determine UVB radiation exposure levels in high-school students during normal daily activity. Digital dosimeters were worn by 4 high-school students during 11 school days. Students were subjected to daily erythemal and suberythemal doses of UVB radiation. Programs to educate high-school students in sun-protective practices even during regular school activities are needed. (J Am Acad Dermatol 2003;49:1112-4.)

At current rates, a skin cancer will develop for 1 in 5 people in the United States during their lifetime.[1] The primary cause for the development of skin cancer is exposure to UV radiation. The UVB band (290-320 nm) has been most closely associated with sunburning and the development of skin cancer. According to 1 estimate, almost 80% of a person's lifetime sun exposure occurs before the age of 18 years.[2] The purpose of this study was to assess the amount of UVB radiation exposure received by high-school students while engaged in typical daily school activities.

MATERIALS AND METHODS

In all, 4 high-school students at Riverdale Country School, New York, NY (ages 12-17 years) agreed to be volunteers. Each volunteer was given a personal digital UVB dosimeter (Advanced Medical Electronics, Findlay, Minn) to wear on their wrists from 8 AM to 5 PM for the 11-day study period in May 2001 (Fig 1). Dosimeters were placed on wrists outside coat sleeves for outdoor exposure measurements on cooler days. It has been shown that dosimeters worn on wrists are an effective method to measure UVB radiation exposure.[3] Volunteers participated only in regular academic school activities during the study period with UV exposure occurring primarily during the change of classes and outdoor social activities.

UV radiation energy is measured in joules (watt-seconds) and UV irradiance in W/U area (W/cm^2). Cumulative UV radiation exposure is equal to irradiance × time (mJ/cm^2).

The dosimeters measured UVB irradiance (mW/cm^2) 3 times in each 5-minute interval during the study period and recorded the highest of the 3 values. The data were then downloaded from the dosimeter chips, integrated over each study day, analyzed, and converted to UV radiation exposure (irradiance × time [mJ/cm^2]). Degree of cloud cover was recorded for all days in the study using the following subcategories: sunny, partly cloudy, and cloudy.

RESULTS

The overall average UVB radiation exposure was 8.01 $mJ/cm^2/d$. The average exposure was 5.83, 7.15, and 14.55 mJ/cm^2 on primarily cloudy, partly cloudy, and primarily sunny days, respectively (Table I).

DISCUSSION

This study has shown that high-school students are exposed to measurable levels of UVB radiation in their day-to-day school activities. Although the data showed that the UVB radiation exposure was higher for sunny days than for cloudy days, the exposure levels received by the students even on the cloudy days were significant. The amount of UVB radiation that will sunburn (minimum ery-

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Fig 1. Digital dosimeter used by study volunteers on wrists to measure UVB exposure.

Table I. Average UVB radiation exposure received by study volunteers by hour of exposure and cloud cover

Hour starting	Sunny	Partly cloudy	Cloudy	Average
8	1.33*	.45	.28	.50
9	1.22	1.97	.20	.90
10	.29	1.02	.93	.86
11	2.48	.43	.57	.82
12	.34	.19	.43	.34
1	.91	1.15	1.39	1.21
2	3.43	1.43	.65	1.78
3	3.40	.18	.49	.84
4	1.15	.33	.89	.76
Daily total	14.55	7.15	5.83	8.01

*Data expressed as milijoules per centimeter squared.

thema dose) a fair-skinned (Fitzpatrick type I) person is approximately 10 to 25 mJ/cm^2.[4,5] Therefore, students of type I phenotype were exposed to an amount of UVB radiation that could cause sunburning even during regular school activities. Because sunburns during adolescence increase later melanoma risk,[6] this finding is of particular concern.

Although the mean daily exposure was less than 1 minimum erythema dose for those with darker phenotypes on even the sunny study days, other studies have demonstrated that chronic exposures to lesser amounts of UVB can also cause damage to the skin. It has been shown that repeated suberythemal doses can mutate the DNA of an individual and lead to pyrimidine dimer formation in dermal and epidermal tissue.[7]

Several factors may have affected the observed UVB values. The study was conducted during May, which is the nearest month of the school year to the summer solstice. Therefore, the values measured were near the highest for the entire school year. In addition, the study was performed at a midlatitude sea level region in the United States. The observed value would, therefore, be higher in the southern United States and in areas with sunnier climates.[8] Had the study been conducted at higher altitudes, the level of UVB irradiance and exposure would have been higher.[9]

These data show that during the hour that began at 12 PM, the radiation exposure was lower than the hours immediately before or after. This was probably because the students spent the majority of this hour eating lunch indoors. Then, immediately after, the students went outside until their lunch period was finished. This is shown by the exposure values increasing at that time. Also, no data for the study were collected during organized school sporting activities. It is expected that students engaged in organized outdoor school sports would be exposed to higher UV levels.

The study has demonstrated that high-school students in their day-to-day activities may be exposed to measurable erythemal and suberythemal levels of UVB radiation that can damage their skin over time and potentially affect their later risk for skin cancer. Teenagers have been shown to be aware of the fact that sun exposure can lead to skin cancer, but this knowledge appears to have little relationship with the adoption of sun-protective behaviors.[10] It has been demonstrated that well-conducted health promotion campaigns can play a part in reducing sunburn risk,[11] but that programs must be specifically designed with a focus on teenagers to have a reasonable chance for success.[12] Tailored sun-protection education programs to encourage behavioral changes in high-school students (eg, hats, sunscreen, shade) to enhance their protection from UV radiation exposure should be developed and implemented for this population.

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